

Diets of Individuals Based on Energy Intakes From Added Sugars

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“Pooh, do you want honey in your tea?” “Yes, Piglet, but without the tea.”

—*Walt Disney Winnie the Pooh video series.*

Data from the U.S. Department of Agriculture’s (USDA) Nationwide Food Consumption Survey (NFCS) and the Continuing Survey of Food Intakes by Individuals (CSFII) show a steady increase in people’s total energy intake since 1987 (9,10,12). Diet quality as measured by the Healthy Eating Index showed that, from 1989 to 1996, while the intakes of grain products increased appreciably, those of milk decreased (1).

Harnak et al. (3), in a study using CSFII 1994 data, reported that a high level of soft drink consumption by children and adolescents was associated with low intakes of milk and fruit juices and with low intakes of several nutrients: such as calcium, phosphorus, riboflavin, vitamin A, folate, and vitamin C. Non-diet soft drinks; fruit drinks; and foods such as cakes, cookies, and pies, placed under grain products in the CSFII, are high contributors of added sugars in the American diet.

According to per capita data from the U.S. food supply, consumption of added sugars in 1997 was 53 teaspoons per day, reflecting a 28-percent increase from 1982 (7). Added sugars are generally considered “empty calories,” because added sugars are good sources of energy and often are poor sources of micro-nutrients. This study examines the intakes of food groups and nutrients by individuals grouped by the caloric contribution of added sugars to their diet. The study also attempts to determine

whether high intakes of added sugars displace essential nutrients or nutrient-dense foods in the individual’s diet.

Method

CSFII Definition of Added Sugars

Added sugars include all sugars used as ingredients in processed and prepared foods such as breads, cakes, soft drinks, jam, and ice cream, and sugars eaten separately or added to foods at the table (10). Specifically, added sugars include white sugar, brown sugar, raw sugar, corn syrup, corn-syrup solids, high-fructose corn syrup, malt syrup, maple syrup, pancake syrup, fructose sweetener, liquid fructose, honey molasses, anhydrous dextrose, and crystal dextrose. Added sugars do not include naturally occurring sugars such as lactose in milk or the fructose in fruits.

Data Source

Data from USDA’s 1994-96 CSFII, a nationally representative food consumption survey, were used for this study (8). The dietary data were collected on 2 nonconsecutive days (3 to 10 days apart). A multiple-pass approach was used to collect two interviewer-administered 24-hour recalls. Individuals 2 years old and over who were selected for this study had a complete food intake record on day 1 of the survey.¹

¹Overall, the response rate for day 1 was 80 percent and included 15,016 individuals 2 years old and over (8).

Analysis revealed some extreme values for the day's total energy. Therefore, the top (more than 5,200 kcals) and bottom (less than 490 kcals) 1 percent of the individuals were excluded from the analysis. Also, excluded from the analysis were three individuals who had energy intakes entirely from added sugars. The analysis included 14,709 individuals.

The individuals were divided into three groups based on the percentage of calories consumed from added sugars. Group 1 (N=5,058) had less than 10 percent of its total calories from added sugars; group 2 (N=4,488), between 10 and 18 percent; and group 3 (N=5,158), more than 18 percent of its total calories from added sugars.

Data Analysis

Day-1 full sample weights were used to represent the population under study. SUDAAN (release 7.5.1, Research Triangle Institute) was used to compare the three groups' mean intakes of food groups, nutrients, and energy. Three pairwise comparisons of the means were made, and linear contrasts were used to separate the means. A probability level of 0.0125 was used to keep the total experimental error rate low, and SAS software package (release 6.12, SAS Institute, Cary, NC) was used to compute all the other estimations.

Results

Group 1 had the lowest intakes of energy and added sugars among the three groups (table 1). Group 1 consumed 1,860 kcal and 26 grams of sugar: 180 to 189 kcal and 45 to 111 grams less than that consumed by the other groups. There were no significant differences in total fat and saturated fat intakes of group 1

Table 1. Mean¹ intakes of energy, macronutrients, and percentage of calories in a day by individuals 2 years and over, by percentage of calories from added sugars

Energy and nutrients	Calories from added sugars					
	Less than 10% (Group 1)		10 to 18% (Group 2)		Above 18% (Group 3)	
Sample	5,058		4,488		5,158	
	<i>Mean</i>	<i>S.E.</i> ²	<i>Mean</i>	<i>S.E.</i> ²	<i>Mean</i>	<i>S.E.</i> ²
Energy (kcal)	1860 ^a	15.0	2040 ^b	18.1	2049 ^b	17.2
Total fat (g)	73 ^a	0.9	78 ^b	0.1	70 ^a	0.8
Saturated fat (g)	24 ^a	0.3	27 ^b	0.4	25 ^a	0.3
Carbohydrate (g)	211 ^a	1.7	256 ^b	2.2	292 ^c	2.4
Protein (g)	81 ^a	0.7	78 ^b	0.7	66 ^c	0.7
Dietary fiber (g)	17 ^a	0.2	16 ^a	0.2	13 ^b	0.2
Added sugars (g)	26 ^a	0.3	71 ^b	0.7	137 ^c	1.3
Percent of calories from total fat (%) ³	35.3		34.4		30.7	
Percent of calories from added sugars (%) ³	5.6		13.9		26.7	

¹Means with identical superscripts are not significantly different from each other at $p < 0.0125$.

²Standard error of the mean.

³No statistical test of significance was done.

Note: Linear contrasts were used to separate the means.

Source: USDA's Continuing Survey of Food Intakes by Individuals 1994-96, Day-1 data.

and group 3, but their fat intakes were lower than those of group 2. The diets of all three groups, however, had more than 30 percent of calories from total fat.

Group 1, consuming less than 10 percent of calories from added sugars, had much higher intakes of protein and dietary fiber than did group 3, which consumed more than 18 percent of calories from added sugars. Although group 1 had a diet with apparently less carbohydrate than did the other two groups, when the added sugars were subtracted from total carbohydrate, the amount of

carbohydrate without the added sugar was the same as that of group 2, and much higher than that of group 3. That is, compared with group 3, group 1 had a diet higher in carbohydrate without the added sugars.

Group 3, having consumed more than 18 percent of calories from added sugars, had the lowest mean absolute intakes of all the micronutrients, especially vitamin A, vitamin C, folate, vitamin B₁₂, calcium, phosphorus, magnesium, and iron (table 2). Group 1 and group 2 had similar intakes of most micronutrients in absolute amounts; the

Table 2. Mean¹ intakes of micronutrients in a day by individuals 2 years and over, by percentage of calories from added sugars

Nutrients	Calories from added sugars					
	Less than 10% (Group 1)		10% to 18% (Group 2)		Above 18% (Group 3)	
Sample	5,058		4,488		5,158	
	<i>Mean</i>	<i>S.E.</i> ²	<i>Mean</i>	<i>S.E.</i> ²	<i>Mean</i>	<i>S.E.</i> ²
Thiamin (mg)	1.6 ^a	0.01	1.7 ^a	0.02	1.5 ^b	0.02
Riboflavin (mg)	1.9 ^a	0.02	2.0 ^b	0.02	1.8 ^c	0.02
Vitamin A (RE)	1080 ^a	23.0	1031 ^a	26.8	850 ^b	20.2
Vitamin E (mg)	8.3 ^a	0.13	8.4 ^a	0.15	7.1 ^b	0.12
Vitamin C (mg)	106 ^a	2.2	101 ^a	1.8	90 ^b	1.5
Niacin (mg)	23 ^a	0.2	23 ^a	0.3	20 ^b	0.3
Vitamin B ₆ (mg)	1.9 ^a	0.02	1.9 ^a	0.02	1.6 ^b	0.02
Folate (mcg)	275 ^a	3.6	272 ^a	3.8	228 ^b	3.6
Vitamin B ₁₂ (mcg)	5.4 ^a	0.18	5.2 ^a	0.23	4.3 ^b	0.13
Calcium (mg)	788 ^a	8.1	838 ^b	10.1	745 ^c	11.0
Phosphorus (mg)	1251 ^a	9.4	1277 ^a	12.5	1130 ^b	11.4
Magnesium (mg)	285 ^a	2.4	277 ^a	3.1	233 ^b	2.6
Iron (mg)	15.6 ^a	0.14	16.1 ^a	0.19	14.1 ^b	0.18
Zinc (mg)	11.5 ^a	0.15	11.6 ^a	0.15	10.1 ^b	0.13
Copper (mg)	1.2 ^a	0.01	1.2 ^a	0.01	1.1 ^b	0.01

¹Means with identical superscripts are not significantly different from each other at $p < 0.0125$.

²Standard error of the mean.

Note: Linear contrasts were used to separate the means.

Source: USDA's Continuing Survey of Food Intakes by Individuals 1994-96, Day-1 data.

Group 3 had the lowest intakes of all the micronutrients.

exceptions were riboflavin and calcium. Group 3 also had the lowest intakes of all the micronutrients as measured by percentages of 1989 Recommended Dietary Allowances (RDA) (table 3). All three groups had mean intakes less than 100 percent of the RDA for vitamin E, calcium, and zinc (6). In addition, group 3 had mean intakes less than 100 for vitamin B₆ and magnesium. A remarkably lower percentage of individuals in group 3 met their RDA for many micronutrients (table 4). However, more or

less similar percentages of individuals in groups 1 and 2 met the RDA for the micronutrients. Whereas about one-fourth of the individuals with a low intake of added sugars (group 1) had energy intakes that equaled or exceeded the Recommended Energy Allowances (REA), about one-third each of the individuals with moderate or high intakes of added sugars did so.

In addition, group 3 (more than 18 percent of calories from added sugars)

had the lowest intakes of many food groups: Grain; Fruit; Vegetables; and Meat, Poultry, and Fish (table 5). Individuals with low intakes of added sugars included more fruits; vegetables; and meat, poultry, and fish in their diet, compared with food intakes of the other two groups. Dairy intake was the same for the groups with low (group 1) or high intake (group 3) of added sugars.

Analysis of mean intakes of selected food subgroups shows that group 3 consumed less citrus and noncitrus fruit juices and total fluid milk than did the other two groups (table 6). Also, compared with the other groups, group 3 had the highest intakes of regular fruit drinks, punches, and ades; regular carbonated soft drinks; cakes, cookies, and grain-based pastries; milk desserts; and candies. Group 2 had the second highest intakes, and group 1 had the least intakes of these food subgroups. The increase was more than tenfold between group 1 and group 3 for regular fruit drinks, punches, and ades; and regular carbonated soft drinks.

Additional analysis showed that among males, 34 percent were in group 1; 30 percent, group 2; and 36 percent in group 3. Similar percentages of females were in each group: 33 percent were in group 1; 30 percent, group 2; and 37 percent were in group 3. Forty-four percent of African Americans, compared with 33 percent of Caucasians, were in group 3. Among the individuals from households with income less than 300 percent of poverty, about 40 percent were in group 3, compared with less than one-third who were in group 1. When household income levels were at or above 300 percent of poverty, individuals were about as likely to be in group 3 as in group 1: 34 and 35 percent, respectively.

Table 3. Mean¹ intakes of energy and micronutrients as percentage of 1989 Recommended Dietary Allowances (RDA) in a day by individuals 2 years and over, by percentage of calories from added sugars

Energy and nutrients (% RDA)	Calories from added sugars					
	Less than 10% (Group 1)		10% to 18% (Group 2)		Above 18% (Group 3)	
Sample	5,058		4,488		5,158	
	<i>Mean</i>	<i>S.E.</i> ²	<i>Mean</i>	<i>S.E.</i> ²	<i>Mean</i>	<i>S.E.</i> ²
Energy	81 ^a	0.5	89 ^b	0.8	88 ^b	0.8
Vitamin A (RE)	128 ^a	2.8	125 ^a	3.0	103 ^b	2.4
Vitamin E	95 ^a	1.4	97 ^a	1.6	82 ^b	1.5
Vitamin C	185 ^a	3.9	179 ^a	3.0	163 ^b	2.8
Thiamin	139 ^a	1.2	143 ^a	1.5	124 ^b	1.5
Riboflavin	141 ^a	1.1	148 ^b	1.8	130 ^c	1.7
Niacin	150 ^a	1.1	150 ^a	1.7	129 ^b	1.4
Vitamin B ₆	111 ^a	1.1	112 ^a	1.4	94 ^b	1.1
Folate	167 ^a	2.5	175 ^a	2.5	149 ^b	2.5
Vitamin B ₁₂	289 ^a	9.6	285 ^a	11.8	237 ^b	7.0
Calcium	93 ^a	1.0	97 ^a	1.1	83 ^b	1.2
Phosphorus	149 ^a	1.1	148 ^a	1.4	126 ^b	1.4
Magnesium	104 ^a	0.9	105 ^a	1.4	89 ^b	1.1
Iron	142 ^a	1.4	145 ^a	1.8	124 ^b	1.6
Zinc	87 ^a	1.1	89 ^a	1.1	78 ^b	1.0

¹Means with identical superscripts are not significantly different from each other at $p < 0.0125$.

²Standard error of the mean.

Note: Linear contrasts were used to separate the means.

Source: USDA's Continuing Survey of Food Intakes by Individuals 1994-96, Day-1 data.

Independent of gender, the percentage of individuals with more than 18 percent of calories from added sugars (group 3) increased from the childhood years to the teen years and declined in the adult years (table 7). About one-third of children 2 to 5 years old, and one-half of children 6 to 11 years old were in group 3.

Discussion and Conclusion

High intake of added sugars had a dilution effect on many essential micronutrients—especially vitamin A, vitamin B₁₂, folate, magnesium, and iron—in the diet of Americans 2 years old and over. Individuals who consumed more than 18 percent of calories from added sugars had low intakes of all the five food groups.

Table 4. Percentage of individuals 2 years and over meeting 100 percent of 1989 Recommended Dietary Allowances (RDA) for selected nutrients and energy in a day, by percentage of calories from added sugars

Energy and nutrients (% RDA)	Calories from added sugars		
	Less than 10% (Group 1)	10% to 18% (Group 2)	Above 18% (Group 3)
Sample	5,058	4,488	5,158
	<i>Percent</i>		
Energy	24	32	32
Protein	78	80	70
Vitamin A (RE)	42	44	34
Vitamin E	34	35	26
Vitamin C	59	61	52
Thiamin	68	71	59
Riboflavin	68	72	61
Niacin	74	74	62
Vitamin B ₆	49	50	37
Folate	66	67	55
Vitamin B ₁₂	75	78	73
Calcium	37	39	30
Phosphorus	73	75	62
Magnesium	42	43	31
Iron	62	64	52
Zinc	29	32	23

Note: SAS analysis of weighted data.

Source: USDA's Continuing Survey of Food Intakes by Individuals 1994-96, Day-1 data.

High intake of added sugars had a dilution effect on many essential micro-nutrients...in the diet of Americans 2 years old and over.

And compared with other groups, group 3 had the lowest intakes for all the micronutrients. Thus group 3 had the least nutrient-dense diet. Adequate intake of micronutrients has implications for long-term well-being. A high percentage of the adult skeleton is formed during adolescence (5). Thus adequate intake of calcium during childhood and adolescence is essential. Also increased risk of osteoporosis is associated with

low bone density, which results from inadequate intakes of calcium during the growing years (2).

With the lowest intakes of both energy and added sugars, group 1 did not have a lower percentage of calories from added sugars by eating more of other energy-giving nutrients (thereby increasing the denominator) but by controlling the intake of added sugars.

Although the individuals in group 1 had more than 30 percent of total calories from fat, their absolute mean intakes of total fat and saturated fat were similar to those of group 3 and less than those of group 2. Though only one-fourth of group 1 met their energy requirements, in the cases of micronutrients, the percentage of individuals meeting the recommended nutrient levels were comparable to that of group 2.

Compared with the others, group 3 had a high-energy and a relatively lower fat diet. A study by Kennedy et al. (4), using day-1 data from CSFII 1995, showed that children 6 to 18 years old and females 19 to 50 years old whose diets had less than 30 percent of calories from fat had a higher intake of total sugars and sweets and total beverages (excluding milk and fruit juices). The same study also showed that all adults ages 19 to 50 with diets less than 30 percent of calories from fat and whose diets did not include any fat-modified, lean or lower fat food products had a high intake of regular carbonated beverages.

The study showed that children were more likely to have a diet high in added sugars. Adults over 40 years were likely to have lower added sugar intakes. Within the same age group, the gender did not seem to affect the percentage of caloric contribution of added sugars. Group 3 had high consumption of beverages that are very low in nutrients and high in energy. Because of the increasing prevalence of obesity, consumers will be benefitted by limiting intake of “empty” calories, especially during childhood and adolescence.

Table 5. Mean¹ intakes of Pyramid food group servings in a day by individuals 2 years and over, by percentage of calories from added sugars

Food groups	Calories from added sugars					
	Less than 10% (Group 1)		10% to 18% (Group 2)		Above 18% (Group 3)	
Sample	5,058		4,488		5,158	
	<i>Mean</i>		<i>Mean</i>		<i>Mean</i>	
	<i>S.E.²</i>		<i>S.E.²</i>		<i>S.E.²</i>	
Grain	6.7 ^a	0.08	7.1 ^b	0.07	6.3 ^c	0.07
Fruit	1.8 ^a	0.04	1.6 ^b	0.04	1.2 ^c	0.04
Vegetable	3.7 ^a	0.06	3.5 ^b	0.05	2.9 ^c	0.05
Dairy	1.5 ^a	0.02	1.6 ^b	0.03	1.4 ^a	0.03
Meat, poultry, and fish (ounces)	4.6 ^a	0.06	4.3 ^b	0.07	3.7 ^c	0.07

¹Means with identical superscripts are not significantly different from each other at $p < 0.0125$.

²Standard error of the mean.

Note: Linear contrasts were used to separate the means.

Source: USDA's Continuing Survey of Food Intakes by Individuals 1994-96, Day-1 data.

Table 6. Mean¹ intakes of selected food subgroups in a day by individuals 2 years and over, by percentage of calories from added sugars

Food subgroups	Calories from added sugars					
	Less than 10% (Group 1)		10% to 18% (Group 2)		Above 18% (Group 3)	
Sample	5,058		4,488		5,158	
	<i>Mean</i>		<i>Mean</i>		<i>Mean</i>	
	<i>S.E.²</i>		<i>S.E.²</i>		<i>S.E.²</i>	
Citrus juices	79 ^a	4.1	63 ^b	3.8	42 ^c	2.1
Noncitrus fruit juices and nectars	33 ^a	2.1	28 ^a	1.6	16 ^b	1.3
Total fluid milk	201 ^a	5.6	205 ^a	5.0	160 ^b	3.8
Regular fruit drinks, punches, and ades	12 ^a	1.2	67 ^b	3.0	149 ^c	5.7
Regular carbonated soft drinks	32 ^a	2.1	176 ^b	5.5	515 ^c	14.0
Cakes, cookies, and grain-based pastries	18 ^a	0.8	43 ^b	1.6	53 ^c	1.8
Milk desserts	11 ^a	0.7	27 ^b	1.1	41 ^c	1.8
Candies	2 ^a	0.2	6 ^b	0.4	13 ^c	0.7

¹Means with identical superscripts are not significantly different from each other at $p < 0.0125$.

²Standard error of the mean.

Note: Linear contrasts were used to separate the means.

Source: USDA's Continuing Survey of Food Intakes by Individuals 1994-96, Day-1 data.

Table 7. Percentage of individuals, by age-gender and by percentage of calories from added sugars

Age (years)- gender group	Calories from added sugars		
	Less than 10% (Group 1)	10% to 18% (Group 2)	Above 18% (Group 3)
Sample	5,058	4,488	5,158
		<i>Percent</i>	
All individuals	34	30	36
Child 2-5	29	36	35
Child 6-11	30	31	49
Male 12-18	16	28	56
Female 12-18	17	30	53
Male 19-40	32	31	37
Female 19-40	32	28	40
Male 41 and over	45	30	25
Female 41 and over	43	30	27

Note: SAS analysis of weighted data.

Source: USDA's Continuing Survey of Food Intakes by Individuals 1994-96, Day-1 data.

African Americans and low-income individuals were more likely than their counterparts to have high intakes of added sugars. It is possible that foods high in added sugars were less expensive energy sources for at least some of the individuals in the low-income group. Income could play a role in the choice of foods because higher consumption of expensive foods such as fruits and vegetables was associated with diets where added sugars were low.

When the total fat intake meets the recommendations of the *Dietary Guidelines for Americans* (13), the Food Guide Pyramid suggested levels of added sugars are 6, 12, and 18 teaspoons (24, 48, and 72 grams) per 1,600, 2,200, and 2,800 calories of total energy per day, respectively (11). The mean intake of

added sugars for group 3 was 137 grams, which is much higher than these recommended levels.

Data on food disappearance (in the food supply) show that more than three-quarters of the refined and processed sugars reach the consumer through food and beverage industries, and less than one-fourth of the amount produced is brought directly into the home (1). It is important for consumers to recognize that they get large amounts of added sugars through processed foods and beverages. Additional analyses of data from day 1 of the CSFII 1994-96 show that individuals 2 years old and over (N=15,016) consume 20.5 teaspoons (82 grams) of added sugars daily. The top five sources of added sugars and their mean contribution to the daily intakes of added sugars in the

diet are carbonated soft drinks (27 grams); cakes, cookies, pies, sweet rolls, and other grain-based pastries (11 grams); fruit drinks (excludes fruit juices), punches, and ades (8 grams); dairy desserts (4 grams); and all types of candies (4 grams).

Food labels contain information on total sugars per serving but do not distinguish between sugars naturally present in foods and added sugars. Better information on the food label is needed to help consumers make informed choices regarding added sugars.

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References

1. Bowman, S.A., Lino, M., Gerrior, S.A., and Basiotis, P.P. 1998. The Healthy Eating Index: 1994-96. *Family Economics and Nutrition Review* 11(3):2-14.
2. Food and Nutrition Board, Institute of Medicine. 1998. *Dietary Reference Intakes. Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride*. National Academy Press, Washington, DC.
3. Harnack, L., Stang, J., and Story, M. 1999. Soft drink consumption among US children and adolescents: Nutritional consequences. *Journal of the American Dietetic Association* 99(4):436-441.
4. Kennedy, E.T., Bowman, S.A., and Powell, R. 1999. Dietary-fat intake in the U.S. population. *Journal of the American College of Nutrition* 18(3):207-212.
5. National Institute of Health Consensus Development Panel on Optimal Calcium Intake. 1994. *Journal of the American Medical Association* 272:1942-1948.
6. National Research Council, Subcommittee on the Tenth Edition of the RDAs, Food and Nutrition Board. 1989. *Recommended Dietary Allowances* (10th ed.). National Academy Press, Washington, DC.
7. Putnam, J. and Gerrior, S. 1999. Trends in the U.S. Food Supply. In E. Frazao (Ed.) *America's Eating Habits: Changes and Consequences* (pp. 133-160). U.S. Department of Agriculture, Agriculture Information Bulletin No. 750.
8. Tippet, K.S. and Cypel, Y.S. (Eds.). 1998 (May). *Design and Operation: The Continuing Survey of Food Intakes by Individuals and the Diet and Health Knowledge Survey, 1994-96*. U.S. Department of Agriculture, Agricultural Research Service. NFS Report No. 91-1.
9. U.S. Department of Agriculture, Agricultural Research Service. 1995. *Food and Nutrient Intakes by Individuals in the United States, 1 Day, 1989-91*. Nationwide Food Surveys. Report No. 91-2.
10. U.S. Department of Agriculture, Agricultural Research Service. 1998. *Food and Nutrient Intakes by Individuals in the United States, by Sex and Age, 1994-96*. Nationwide Food Surveys. Report No. 96-2.
11. U.S. Department of Agriculture, Human Nutrition Information Service. 1992. *The Food Guide Pyramid*. Home and Garden Bulletin No. 252.
12. U.S. Department of Agriculture, Human Nutrition Information Service. 1993. *Food and Nutrient Intakes by Individuals in the United States, 1 Day, 1987-88*. Nationwide Food Consumption Survey 1987-88, NFCS Report No. 87-1.1.
13. U.S. Department of Agriculture and U.S. Department of Health and Human Services. 1995. *Nutrition and Your Health: Dietary Guidelines for Americans* (4th ed.). U.S. Department of Agriculture. Home and Garden Bulletin No. 232.